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Fall and Winter Habitat of Ruffed Grouse in the Qu'Appelle Valley, Saskatchewan

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SUMMARY

1. The fall and winter habitat of the ruffed grouse *(Bonasa umbellus)* was studied in the Qu'Appelle Valley of southern Saskatchewan during 1977 and 1978.

2. Four major habitats were recognized: trembling aspen *(Populus tremuloides)*, Manitoba maple *(Acer negundo)*, bur oak *(Quercus macrocarpa)* and green ash *(Fraxinus pennsylvanica)*-shrub woodlands. Approximate fall population densities in each of these habitats were 32-45, 18-19, 17-30, and 37-60 grouse per km² respectively. Densities in the some aspen areas (47-86 grouse per km²) exceeded many high population densities reported in the literature.

3. Aspen made up much of the tree cover at fall and winter observation sites. Maple, oak, balsam poplar *(Populus balsamifera)* and ash followed in importance. Important tall shrub cover species were chokecherry *(Prunus virginiana)*, saskatoon *(Amelanchier alnifolia)*, willow *(Salix spp.)*, beaked hazelnut *(Corylus cornuta)*, red-osier dogwood *(Cornus stolonifera)*, aspen saplings and hawthorn *(Crataegus rotundifolia)* in descending order of use. Western snowberry *(Symphoricarpos occidentalis)* and rose *(Rosa spp.)* were the most common low cover plants but herbaceous cover was poorly represented. Habitat preferences of ruffed grouse in fall and winter were similar.

4. Grouse most frequently used habitats with well-developed tall shrub and tree strata. Aspen (and associated shrubs) and chokecherry were important cover plants in most habitats. Abundant ground cover seemed to be avoided as were steeper slopes.

5. Grouse were most numerous on roadside count routes where aspen and chokecherry were common. Regression analysis indicated that other plants had far less influence on grouse densities in these areas.

6. During winter, there were significant decreases in numbers of grouse observed on census routes with "marginal" habitats. Numbers in "good" habitats, where chokecherry, aspen and associated shrubs were abundant, remained stable throughout the winter. Data from fall surveys and spring counts of drumming males also indicated that losses during fall and winter were greatest in non-aspen habitats.

7. Densities of drumming males were greatest in aspen woodlands but much lower in other habitats. Drumming males preferred ungrazed or lightly grazed woodlands with trees greater than 10 m in height.

8. Important fall foods of ruffed grouse in the Qu'Appelle Valley and the Moose Mountain area were: fruits of chokecherry, rose and hawthorn; green materials (especially clover, *Trifolium spp.*); beaked hazelnut catkins; and a variety of other fruits, buds, and twigs. The tall shrub layer produced 61% of the fall food, low shrubs 20%, the herb layer 18%, and trees 2%. In winter, grouse fed most frequently on chokecherry (46% of 85 observations of feeding grouse) and aspen (14%).

9. Grouse were highly dispersed in early fall but tended to form aggregations in late fall and early winter. After January, the frequency of aggregations decreased.

10. Based on the present and previous studies, there are several potentially useful management practices for maintaining high densities of ruffed grouse: a) providing habitats with well-developed tree and tall shrub layers supporting food and vertical cover plants such as aspen, chokecherry, willow, hazelnut and hawthorn; b) restricting the growth of low horizontal cover; c) cutting or burning small patches of aspen to provide optimum interspersion of different successional stages; d) growing vigorous stands of mature chokecherry in non-aspen habitats; and e) limiting grazing by cattle. The effects of such practices on ruffed grouse populations need to be evaluated experimentally.

I. INTRODUCTION

The ruffed grouse *(Bonasa umbellus)* is widely distributed in North America where it is commonly associated with deciduous or mixed-wood forests. Thirteen races of grouse are recognized; each seems to be associated with a particular woodland type (Aldrich 1963). Little is known about the 2 races of ruffed grouse *(B. u. umbelloides* and *B. u. incana)* that occur in Saskatchewan and information about habitat requirements, population densities, and the general biology of the species is lacking for the province. Such information is needed as a basis for the management and conservation of this grouse for interpretive, hunting or other recreational purposes.

Grouse and other animals select habitats which meet their basic ecological requirements. These are termed the "ultimate" causes of habitat selection and include such factors as (Hilden 1965):

a) food supply,

b) requirements imposed by the anatomy and physiology of the species, and,

c) shelter from predators and adverse weather.

A species normally reaches its greatest abundance in habitats where resources which meet these needs are plentiful. A comparison of the physical and biotic features of habitats supporting low and high population densities provides valuable insight into factors that might limit the abundance of a species. From these observations, one can determine the general characteristics of "good" habitats that support many animals and "marginal" habitats that support only sparse populations (Robbins 1978, Anderson 1979a,b).

Food and other habitat conditions are thought to be important factors limiting vertebrate populations (Wynne-Edwards 1962, Lack 1966, Klein 1970). Studies of red grouse *(Lagopus lagopus scoticus)* in Scotland suggest that populations of this species are greatly affected by the quality of their major

food, heather *(Calluna vulgaris)*. The ability of various moors to support grouse relates largely to the richness of the heather on the moor as influenced by fertilization, burning, and general productivity of the site (Moss 1969). Investigations of grouse in North America also intimate that food plays an important role in limiting densities (Gullion 1966b, Svoboda and Gullion 1972, Doerr et al. 1974) but the evidence is not conclusive.

In investigating the ruffed grouse population of the Qu'Appelle Valley, I tried to answer several important questions brought to mind by these and other studies:

a) What are the major habitat types used by ruffed grouse the Qu'Appelle Valley?

b) What are the relative fall and spring population densities of grouse in these habitats and how do they compare to densities reported for other regions?

c) What are the physical and vegetative characteristics of the best habitats and how are these likely to influence population densities of grouse?

d) What are the important fall and winter grouse foods?

e) What steps can be taken to maintain high population levels of grouse in the valley?

At best, a short-term study such as this can only provide partial answers to these questions and the need for further study cannot be overemphasized.

Life History of the Ruffed Grouse

A knowledge of the life history of the ruffed grouse greatly facilitates an understanding of this report. For this reason, a brief description of the habits of this bird, based largely on references by Bump et al. (1947), Gullion

(1972), Bendell (1973), and Johnsgard (1973), is given below.

The male ruffed grouse is territorial and each spring defends a small area of woodland against other males. From one or more display sites, usually old logs, the cock advertises his presence by "drumming" -- rapidly beating his wings to produce a low thumping sound. Drumming serves to establish the cock's position in the forest and to warn other males to keep their distance, as well as to attract potential mates.

The hen is less sedentary in spring and may wander across the territories of several drumming males. Eventually, when she is physiologically ready, she will approach a male and mate with him. The association between the sexes is short-lived and a female may move a distance of 1 km from the drumming log of her mate to lay her clutch of 7 to 14 eggs. If all goes well, the precocial chicks hatch after an incubation period of about 3 weeks. If the eggs are destroyed by predators or lost due to other causes, a replacement clutch may be laid. In southern Saskatchewan, the peak of hatching occurs in late May or early June. Most eggs in successful clutches hatch (a small proportion is lost because of infertility, death of embryos, or other causes) but probably less than 50% of the chicks will survive until fall.

For their first 4 or 5 weeks of life, chicks mainly eat insect food and the hen attempts to select a habitat that will satisfy the nutritional requirements of her brood. As the chicks grow older, succulent plants become an important part of the diet. Throughout summer, the hen and her offspring travel about as a family unit restricting their activities to a well-defined home range. Ruffed grouse are woodland birds and seldom venture far into the open. In the evening, they may wander out to nearby roadsides or the edges of open fields to pick gravel and feed, but most of their life is spent in woods and shrublands. Autumn is a period of unrest for young grouse. At this time, broods break up and juvenile grouse search for

new areas to inhabit. These dispersal movements, which are unidirectional and direct, average perhaps 1 km per day. Studies of grouse equipped with small radio transmitters indicate average dispersal distances of about 3 km, with females moving farther than do males. Dispersal ends when a juvenile grouse settles on its winter range. A grouse may spend the rest of its life within a short distance of this location and, the quality of the habitat chosen at this time may have a great influence on subsequent survival and reproduction.

During fall, ruffed grouse subsist on a variety of fruits, supplemented by green materials and the flower buds and catkins of shrubs and trees. Buds and catkins take on greater importance in the diet as winter approaches and throughout winter, one or two species of plants may supply much of the necessary food. Winter is a time of great physiological stress for many animals but grouse are well-adapted to survive the cold and snow. Their main food supply is not buried beneath the snow and they conserve body heat by roosting, at night and on cold days, in snow burrows.

Ruffed grouse are not long-lived. Of 100 young grouse alive in the fall, on average, less than half will survive until spring, and only 20 will live to see their second spring. Predators, such as great-horned owls *(Bubo virginianus)*, goshawks *(Accipiter gentilis)*, and lynx *(Lynx canadensis)* account for most deaths but many biologists believe that predation normally has little effect on spring to spring changes in numbers. Similarly, low to moderate hunting pressure may have little influence on grouse populations. There appears to be a "doomed surplus" in most fall populations of grouse which, whether hunted or not, will have disappeared by spring.

An interesting and important feature of grouse population dynamics is that, at least in the more northern parts of their range, these animals undergo periods of scarcity and abundance. Peak populations occur at roughly 10-year intervals. Other animals of the boreal region, particularly the snowshoe hare

(Lepus americanus) and its predators, also undergo such fluctuations. There is no general agreement on the causes which underlie the "cycles" although studies in Minnesota suggest that through habitat management, the effect of the "cycles" can be dampened and the long-term abundance of ruffed grouse increased.

II. THE QU'APPELLE VALLEY

The Qu'Appelle Valley (Figure 1) was formed about 14,000 years ago by water draining from glacial meltwater lakes. This torrent eroded a valley up to 140 m deep and 1.5 km wide from the underlying glacial and bedrock deposits (Christiansen 1960) but the typical depth of the valley is 30 to 90 m (Anonymous 1972). Frequent landslides or slumps cause the eastern reaches of the valley to take on a "V" shape while in the west, the valley is typically "U"-shaped.

The Qu'Appelle River is an underfit stream which meanders back and forth across the valley bottom. Numerous small streams feed into the river. Those in the eastern part of the valley are spring-fed and may flow year round while streams in the west are usually intermittent.

The climate of the region is a cold continental type characterized by hot summers, cold winters, moderate precipitation, and variable weather patterns (Chakravarti 1969). The average temperature remains below freezing for 6 months of the year and the annual number of frost-free days is 80 to 100. Annual precipitation is about 40 cm. Snowfall, which makes up 25% of the annual precipitation, averages 90 cm in the west and 140 cm in the east.

Soils of the uplands adjacent to the valley are mainly dark brown chernozems (grassland soils) west of Regina and black chernozems to the east. Light colored forest soils (termed podzols) border the eastern part of the valley in some locations (Moss and Clayton 1969). Hillside soils are poorly developed and the alluvial soils of the flood plain vary greatly in fertility (Mitchell et al. 1944, Ellis et al. 1965).

The Qu'Appelle Valley crosses two commonly recognized vegetation zones -- the mixed-grass prairie and the aspen parkland (Coupland and Rowe 1969). The vegetation of the Qu'Appelle is more representative of parkland

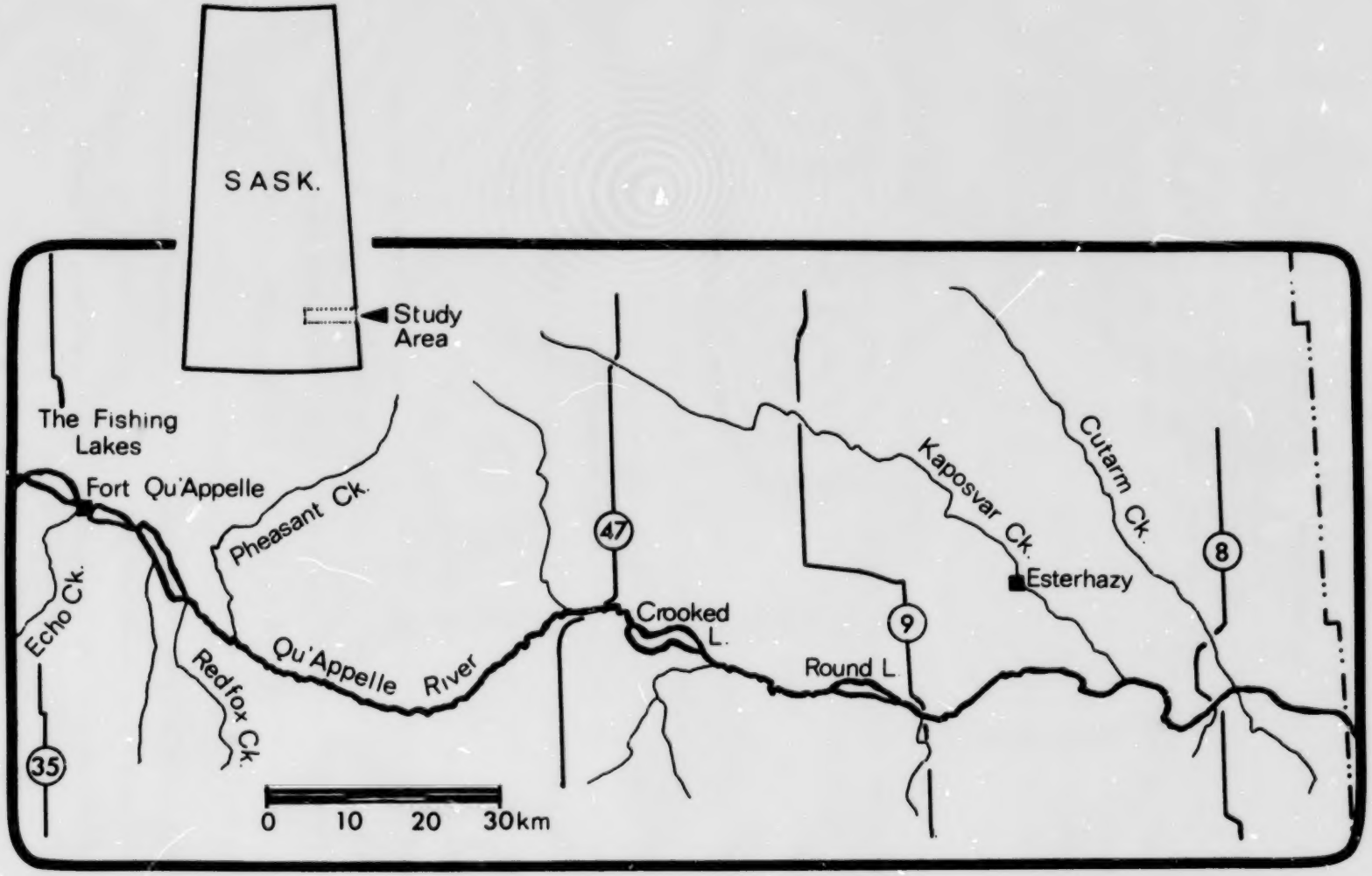

FIGURE 1. The Qu'Appelle Valley.

than grassland but because of the complex nature of the environment, the valley flora is more diverse than that of surrounding uplands. The valley serves as an invasion route for plants still recolonizing the region after the last glaciation and this adds further diversity to the flora. The abundance and diversity of woody plants is great in the eastern part of the valley due to superior moisture conditions as well as the recolonization effect.

Dry hillsides of the western part of the valley support grassland vegetation and shrubs such as chokecherry, saskatoon, roses, wolf-willow *(Elaeagnus commutata)* and snowberry are restricted to moister coulees or more shaded north-facing slopes. Green ash is the major tree species present in these locations. There is no significant development of woody vegetation along the river bank or on the flood plain but further eastward, moisture conditions improve and the valley deepens, providing shaded ravines. Trembling aspen and green ash are dominant on most of the north-facing slopes and the wooded coulees of the south face. Trees and shrubs with greater moisture requirements such as Manitoba maple, white elm *(Ulmus americana)*, balsam poplar, and red-osier dogwood become more abundant. River banks, if they are not flooded frequently or for too long a period, support sand-bar willow *(Salix interior)*, maple, ash or elm. Throughout the valley, much of the flood plain has been broken and is now cropland. Lower parts of the flood plain are prone to frequent flooding and support marsh vegetation.

From Lumsden eastward, most of the north-facing slopes are wooded. Beaked hazelnut, various willows, and high bush-cranberry *(Viburnum trilobum)* are present in the understory of moist aspen woods but saskatoon and chokecherry, which are not shade tolerant, grow along woodland edges or in drier coulees. Clumps of white birch *(Betula papyrifera)* exist on steeper, shaded slopes. Spring seeps are common east of #47 Highway and fen vegetation develops where such sites are poorly drained. Lieffers (1977) has described the flora of such sites.

From #9 Highway eastward to the Manitoba border, bur oak is the dominant tree on exposed slopes. Green ash decreases in importance but maple remains abundant, especially near water courses. Oak woodlands are often savannah-like having a poorly developed tall shrub layer but a significant ground layer of shrubs, forbs, and grasses. The gentler slopes of the "V"-shaped valley and the numerous spring seeps provide diverse habitats for woody plants. Balsam poplar is often dominant at moist sites, and birches, dogwood and willows are common. Sedges *(Carex spp.)* and moisture-loving grasses prevail at spring openings in the woodlands. On mesic but well-drained slopes, aspen is the dominant tree. Hazelnut, dogwood, and, to a lesser degree, bush-cranberries *(Viburnum spp.)* are major understory plants. Saskatoon, chokecherry, hawthorn, and thorny buffaloberry *(Shepherdia argentea)* are restricted to the edges or to drier woodlands. Rowe (1972), in his classification of the forest regions of Canada, has included the eastern part of the valley in the aspen-oak section of the boreal forest. Like the aspen parkland, this is considered as a transition zone between closed forest to the north and prairie to the south.

Detailed descriptions of vegetation as it relates to slope, aspect and other environmental factors, and an annotated list of the plant species recorded in the valley, are presented by Lieffers (1977).

The relationships between land uses such as grazing and fire and the plant communities of the Qu'Appelle Valley are not well understood. In general, fire destroys woody vegetation and stimulates growth of grasses (Daubenmire 1968) but certain woody plants such as aspen, white birch, balsam poplar, beaked hazelnut and various willows are capable of regenerating quickly from their roots and are favored over other shrubs and trees by occasional fires. Other woody plants, for example bur oak, have thick bark which is adapted to resist fire (Hosie 1969). Fire sets back the stage of woodland succession and the resulting seral stages are simple in species composition, but often

very productive and of great value to some species of wildlife.

Light grazing of woodlands reduces the herb layer whereas heavy grazing pressure also reduces the height and abundance of tall shrubs (Weatherill and Keith 1969). In well-shaded communities, especially those dominated by maples, overgrazing can virtually eliminate the shrub layer and smooth brome *(Bromus inermis)* and Canada thistle *(Cirsium arvense)* or other weedy forbs readily invade. Thorny buffaloberry and hawthorn are clearly favored by overgrazing of south-facing slopes and under these circumstances, may form dense thickets. In aspen woods, red-osier dogwood is frequently overbrowsed by cattle while hazelnut is less readily eaten. Several authorities, reviewed by Weatherill and Keith (1969), suggest that most woodland shrubs are palatable to livestock and decrease with increasing grazing pressure. Among the "decreasers" listed in these studies were saskatoon, dogwood, cherries *(Prunus spp.)*, rose, raspberries *(Rubus spp.)*, willows, snowberry, and high bush-cranberry. Many of these plants are likely also decreasers in the Qu'Appelle Valley.

III. METHODS

1. Classification of Habitat

The major kinds of communities used by ruffed grouse were identified by reconnaissance of the wooded areas of the valley. This included mainly the area from Fort Qu'Appelle eastward to the Manitoba border. Habitat types were classified subjectively on the basis of plant species composition, vegetation structure and the abundance of individual species, after the guidelines of Rowe (1969). A plant association qualified as a major habitat type if it met the following criteria:

i) it was recognizable on the basis of vegetation structure, species composition and species abundance;

ii) it was widespread and frequently used by grouse.

2. Fall Population Estimates

Densities of grouse in each major habitat type were estimated using line transects (Leopold 1933:151, Hayne 1949, Gates 1969, Eberhardt 1978). Such transects are simple in principle although statistical problems associated with the technique are complex and need further evaluation (Overton 1969, Eberhardt 1978, Anderson et al. 1979, Burnham et al. 1980). Two different estimators of population density were employed -- those of Hayne (1949) and Gates (1969). To obtain a broad sampling of available grouse habitat, as many different areas and habitat types were inventoried as possible. Many locations were inspected only once and data for all areas of a similar habitat type were pooled. This gave an average density estimate for each particular habitat type and made the sample representative of a wide area. Four areas, designated for intensive investigation, were sampled more frequently. Echo Creek, Bear Creek, Kaposvar Creek, and a bur oak woodland near #8

Highway.

3. Habitat Analysis

a) Grouse Observation Sites

I recorded vegetation and physical characteristics within a 10-m radius of each site where a grouse was observed. During winter, sites where fresh tracks were noticed were also included in the analysis. Location, time of day, slope, aspect, habitat type, and plant species composition were recorded. Slope was estimated as slight (0 to 5°), moderate (6 to 10°), or steep (>10°). Initially, heights (James and Shugart 1970) and diameters at breast height (1.2 m) of tall shrubs and trees were measured at observation sites but later these were estimated visually. The relative amounts of cover provided by the tree, tall shrub and low shrub-herb layers were rated on a scoring system modified from Stewart (1956). A score of "3" indicated that a plant covered >50% of the site, "2" meant 10-50% cover, and "1" indicated <10% cover. A maximum of 6 points was allotted for each layer, but all 6 points were not allotted if cover was sparse.

Three woodland layers were defined as follows:

i) trees - greater than 6 m tall;

ii) tall shrubs (including saplings) - 1 to 6 m tall;

iii) low shrubs-herbs - less than 1 m tall.

b) Roadside Counts of Grouse in Winter

Grouse were counted on 8 roadside routes during the evening. These observations were pooled with counts of fresh tracks made during the day to give an index of grouse abundance for the route.

Vegetation was evaluated at 50 x 50-m plots spaced at 150-m intervals along count routes. The 3,2,1 scoring system described previously was used

to determine plant species composition. Only trees and tall shrubs were considered in the analysis as low vegetation was largely covered by snow. Locations of count routes are shown in Figure 2.

c) Counts of Drumming Males

Springtime counts of drumming males are a useful index to ruffed grouse population density (Petraborg et al. 1953, Gullion 1966a). This technique usually involves stopping at 0.8-km intervals along a road and counting the number of drumming grouse heard during each 4-minute stop. Standard drumming counts were not a useful index to ruffed grouse densities in the Qu'Appelle Valley as many of the roads were located in open areas away from the continuous stretches of grouse habitat on the wooded slopes. Accordingly, I modified the drumming count technique as follows. At representative stands of each major habitat type, I counted drumming grouse for 2-minute periods. The shorter count period helped differentiate between habitats with low and high densities of drumming males. As the results were to be compared statistically as frequency data (i.e. each stop scored as either "grouse heard drumming" or "no grouse heard drumming"), the length of the count interval was critical. Even a woodland supporting a sparse density of grouse might have a high drumming frequency if a long count period was used.

Because of time constraints, drumming counts were extended beyond the early morning period recommended by Petraborg et al. (1953) and a few supplementary counts were made on calm evenings. Habitat type, location, estimated height of the overstory and intensity of livestock grazing were noted for each count site. A wide variety of successional stages and grazing regimes were sampled for each habitat type. A subjective rating of livestock grazing intensity was based on the abundance of livestock trails and droppings, the amount of herbaceous cover not grazed during the previous season, the

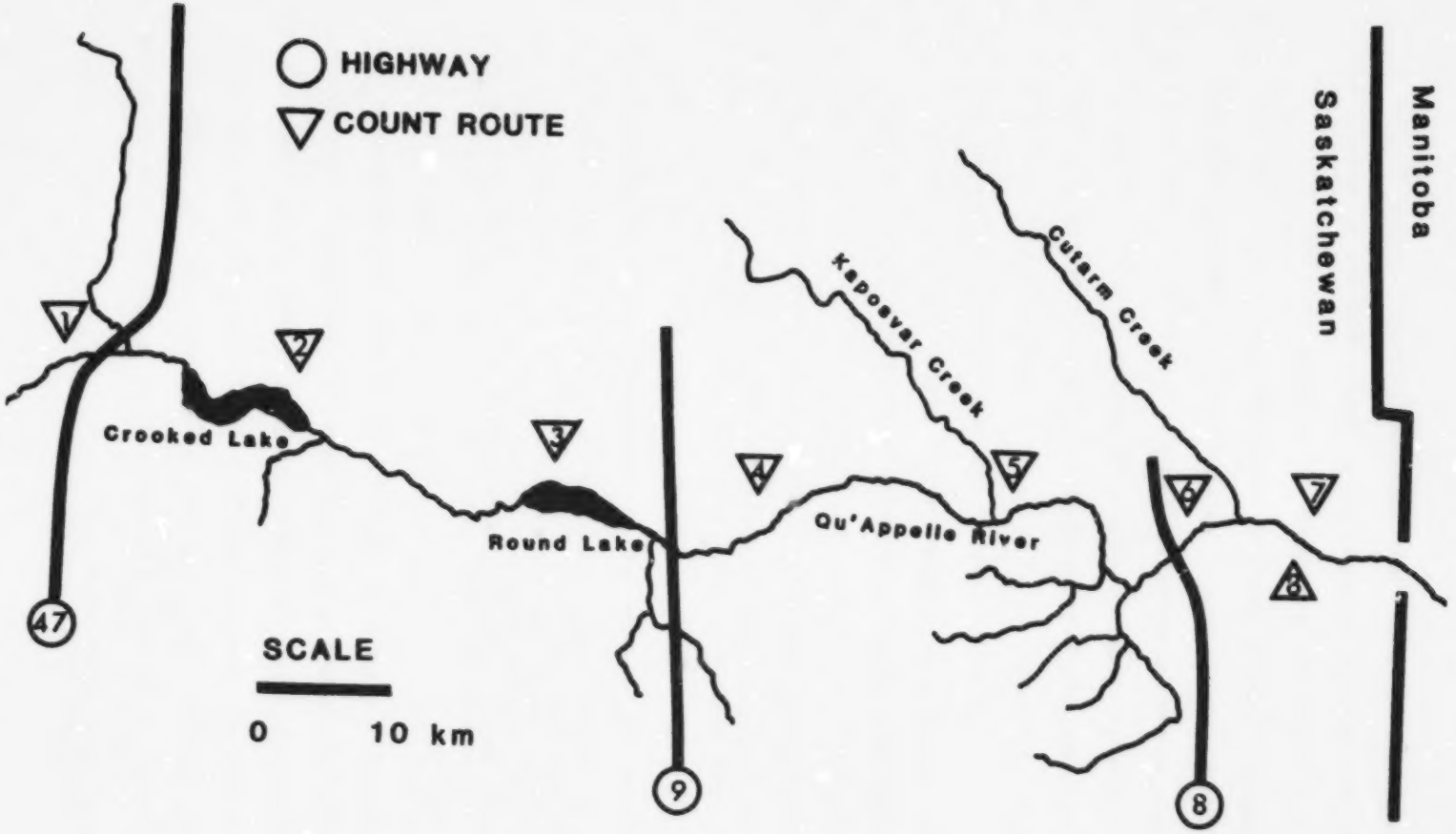

FIGURE 2. Locations of eight roadside grouse count routes in the Qu'Appelle Valley.

relative abundance of "increaser", "decreaser", and "invader" species (Forbes et al. 1973) and the frequency of browsing on shrubs. Intensity of grazing was classified as:

i) ungrazed - no evidence of recent grazing;

ii) lightly grazed - grazing mainly restricted to the herb layer, invader species uncommon;

iii) moderately grazed - effects of grazing on both herb and shrub layers noticeable, livestock trails and droppings common, invader species frequent;

iv) heavily grazed (overgrazed) - invader species common in herb layer, palatable herbs grazed short, shrubby layer significantly sparser and possibly also shorter, trails and droppings abundant.

4. Food Habits

Grouse were collected in the Qu'Appelle Valley during the fall hunting seasons of 1970, 1971, 1977 and 1978. In 1978, additional grouse were collected in the Moose Mountain area of southeastern Saskatchewan about 80 km from the Qu'Appelle Valley. Crop contents of all grouse were analysed using the "aggregate weight" method (Martin et al. 1946, Korschgen 1969). Food items were sorted, oven-dried, and weighed to the nearest 0.01 g on an electronic balance.

Information on winter food habits of ruffed grouse were obtained by observation. When a feeding grouse was observed, I attempted to identify the food plant. This could usually be determined when grouse foraged arboreally in simple communities but, where vegetation was more complex, the food plant was not always identified. Similar techniques have been used for studying ungulate food-habits in the field (Korschgen 1969) as well as those of ruffed grouse (Svoboda and Gullion 1974).

IV. RESULTS AND DISCUSSION

Fall fieldwork began in late September and lasted until mid-November in both 1977 and 1978 while winter fieldwork lasted from December 1977 to late March 1978. Spring field research was conducted in May and June 1978. Work was concentrated in the part of the valley between Fort Qu'Appelle and the Manitoba border in both spring and fall. Most secondary roads were blocked by snow in winter, restricting much of the winter field work to the area east of #47 Highway.

1. Habitat Types

Four major habitat types commonly used by ruffed grouse were recognized on the basis of biophysical characteristics. These habitats merge with other communities as soil moisture and other environmental conditions change but, in general, each is distinct. A brief description of the habitat types is given below.

a) Bur Oak Woodlands

The drier, exposed hillsides east of Round Lake support bur oak woodland or a savannah-like woodland-grassland mixture. This association has not spread extensively west of Round Lake. The western limit of bur oak abundance corresponds roughly to the edge of a bedrock-shale exposure and it is possible that moisture, or other environmental conditions influenced by the shale, are important for the survival of oaks. The western limit of oak distribution is on lands subject to frequent fires and this may also be slowing the spread of this species.

Slow-growing and scrubby in appearance, bur oak is dominant in this open community. Oak usually grows to a height of 4 to 7 m and rarely reaches 10 m in height. In drier savannah, the tall shrub understory is poorly

developed but a ground layer of grasses, forbs, and low shrubs is abundant. Snowberry and rose are typical low shrubs and, on some sites, the high shrub layer is well represented by chokecherry, saskatoon, hawthorn, and thorny buffaloberry. Usually, in these instances, oaks become less abundant. On moister shaded hillsides or in coulees, aspen and oak woods may merge. Shade tolerant tall shrubs such as hazelnut and dogwood become abundant and low shrubs and herbs become sparser except around the woodland edges. Spring seepage areas within oak woodlands support a rich vegetation -- balsam poplar and willows are typical dominants of the tree and shrub layer.

b) Aspen Woodlands

East of Regina, aspen woodlands cover much of the north-facing slope of the valley. Aspens are clearly the dominant trees in this association and in many places are the only tree species present. Balsam poplar is abundant in damper locations and, on steeper slopes near the valley rim, white birch is common. Maple, oak, and ash trees vary in abundance depending on the site. The diverse understory features hazelnut, dogwood, and bush-cranberry Willows are found near moister edges and openings, while saskatoons and chokecherries prefer drier edges. Snowberry and roses are low shrubs found mainly at the edges of aspen woods. Where the tree canopy and tall shrub layer are well developed, the low shrub-herb layer is largely eliminated by shading.

c) Maple Woodlands

Maples, and to a lesser degree elms, balsam poplars, and ashes are typical dominants on the flood plains of the Qu'Appelle River and its tributaries, along lake shores, and at the base of moister coulees. This habitat type is seldom extensive and usually linear in configuration as it is restricted to narrow strips along stream, river, and lake edges. On wetter sites, maple woodlands yield to stands of sand-bar willow and in drier places give way to

ash-shrub or aspen woods.

When the canopy of mature maple is dense, the well-shaded shrub layer is sparse or absent. Typical shrubs found near edges and openings are saskatoon, chokecherry, snowberry, and rose. The natural understory is often eliminated by overgrazing and bromegrass and various weedy forbs readily invade. Because there is often no buffer zone between the narrow flood plain woodlands and bordering farmland, the understory is readily invaded by agricultural weeds.

d) Ash-shrub Woodlands

Steep coulees on the north side of the valley west of Highway #9, are usually moist enough to support woody vegetation but too dry to support large stands of aspen. Communities of green ash, chokecherry, and saskatoon predominate at such locations. Ashes are seldom dense enough to shade out the saskatoons and chokecherries. Low shrubs such as rose and snowberry are found near the edges of woodlands as are occasional dense patches of hawthorn. In damper places there are maples and aspens, but in general, this community lacks both the diversity and productivity of the moister aspen woods. The great density of the tall shrub layer seems to restrict the movements of cattle which have had less impact on ash woodlands than on maple communities.

e) Other Communities

Other types of woodland habitats were not as widespread, or valuable to grouse and are classified together. Examples are stands of sand-bar willow along the river edge and plantations of exotic trees and shrubs. Few grouse were observed in these habitats.

2. Population Densities

The results of fall counts of ruffed grouse in bur oak, aspen, ash-shrub and maple habitats are recorded in Table 1. The aspen communities are further divided by location to show the variability in population density that occurs between areas of the same general habitat type. As some mortality of grouse occurred during the count period, the figures given in Table 1 are likely less than peak fall densities. Estimates of fall densities varied depending on which formula was used in the calculations with the Hayne (1949) formula consistently yielding lower estimates than the Gates (1969) method.

Aspen habitats supported the highest densitites of grouse, from 32 to 45 per km² on the average. Intensive study areas at Bear Creek and Kaposvar Creek supported 2-year averages of 57 to 86 and 47 to 72 grouse per km², respectively. Other suitable areas of aspen woods sustained similar densities. The average fall density in maple woodlands was 18 to 19 grouse per km². This habitat type was less useful to grouse as it was largely overgrazed and lacked a significant tall shrub layer. Overall, from 17 to 30 grouse per km² were found in oak woodlands. Most grouse in this habitat were associated with moist openings or other ecotonal edges featuring a variety of tall shrubs or aspen trees. Few grouse were found in open oak savannah. The density of grouse in the ash-shrub habitat was estimated at 37 to 60 per km² but these estimates might exaggerate actual densities as they were based on only 20.8 km of transects.

Absolute density estimates from line transects are difficult to compare statistically. Therefore, I compared relative densities of grouse (numbers seen per km of transect) in each habitat type using a X^2 test for goodness-of-fit (Snedecor and Cochran 1967). Expected values were based on the assumption that one would find equal numbers of grouse (per km of transect) in each woodland type if habitat had no influence on population density (Appendix I).

TABLE 1. FALL DENSITIES OF RUFFED GROUSE IN VARIOUS HABITATS IN THE QU'APPELLE VALLEY, 1977 AND 1978

HABITAT TYPE	LENGTH OF TRANSECTS (km)			NO. GROUSE OBSERVED			GROUSE PER km			HAYNE (1949)*			GATES (1969)		
	1977	1978	Both	1977	1978	Both	1977	1978	Both	1977	1978	Both	1977	1978	Both
Ash-shrub	6.5	14.3	20.8	2	10	12	0.3	0.7	0.6	20	45	37	25	72	60
Maple	8.9	19.7	28.6	0	10	10	0.0	0.5	0.4	0	25	18	0	27	19
Oak	19.9	15.1	35.0	7	8	15	0.4	0.5	0.4	14	21	17	23	36	30
Aspen (Bear Creek)	17.0	16.2	33.2	21	22	43	1.2	1.4	1.3	54	59	57	81	89	86
Aspen (Kaposvar Creek)	21.1	28.7	49.8	41	37	78	1.9	1.3	1.6	58	38	47	89	59	72
Aspen (Echo Creek)	17.6	--	17.6	10	--	10	0.6	--	0.6	28	--	28	39	--	39
Aspen (Other)	53.6	74.2	127.8	34	48	82	0.6	0.6	0.6	32	32	32	45	46	45
All Habitats	144.6	168.2	312.8	115	135	250	0.8	0.8	0.8	34	35	35	49	49	49

* Densities based on line transects using estimators of Hayne (1949) and Gates (1969) and expressed as grouse per km².

A highly significant difference between observed and expected distributions resulted ($P<0.01$). Inspection of the data reveals that non-aspen habitats supported fewer grouse than expected while the aspen habitats supported higher numbers than expected. A statistical comparison of only the oak, maple, and ash woodlands shows no difference between observed and expected numbers of grouse ($P>0.25$). Thus, ! pooled transect data for all non-aspen communities giving an overall density estimate of 22 to 33 grouse per km² for these areas during the two years of study.

Population densities were remarkably similar in the aspen habitats in 1977 and 1978 but the data in Table 1 suggest that densities of grouse in the other habitats increased from 1977 to 1978. Since much of the area inventoried in 1978 was different from that searched in 1977, the indicated changes in density may only reflect between year differences in the quality of the habitat searched and not true population changes.

As ruffed grouse are thought to be cyclic, peaking in abundance roughly every 10 years, population densities should be interpreted in terms of the cycle. The highest densities expressed in Table 1 may not be maxima for the Qu'Appelle Valley if grouse numbers were not at a peak in 1977 and 1978. Previous high fall populations occurred in 1971 and 1972 but by autumn 1973, grouse were comparatively scarce. This fluctuation roughly corresponds to population changes over the province as a whole as indicated by data on the annual harvest of ruffed grouse (Balez 1969, 1972; Ross 1975). Unquantified observations, made during other years, suggest that densities during population "lows" were several times lower than in 1977 and 1978.

It is interesting to compare densities of grouse in the Qu'Appelle Valley to high densities reported for other parts of North America (Table 2). Gullion (1972) suggested that ruffed grouse densities of 235 per km² can be attained

TABLE 2. SOME HIGH FALL RUFFED GROUSE DENSITITES REPORTED IN THE LITERATURE

LOCATION	PREDOMINANT HABITAT TYPE	GROUSE PER km²	REFERENCE
New York	woodlot	96	Bump *et al.* (1947)
Michigan	?	37	Ruhl*
Michigan	?	74	Fischer*
Michigan	?	47	Ammann*
Michigan	?	52	Ammann*
Michigan	Mixed Woods	91	Palmer (1954)
Michigan	Mixed Woods	61 - 69	Palmer (1956)
Michigan	Islands	41	Moran & Palmer (1963)
Minnesota	Aspen	136	King (1937)
Alberta	Aspen	82 - 118	Fischer & Keith (1974)
Qu'Appelle Valley	Aspen**	47 - 86	Present Study
Qu'Appelle Valley	Aspen***	32 - 45	Present Study
Qu'Appelle Valley	Oak, Ash, Maple	22 - 33	Present Study

* Cited by Keith (1963)
** Best areas
*** Typical areas

under optimum conditions but none of the surveys that I found in the literature reported densities near this level. The highest density of 138 grouse per km² was reported by King (1937) for Minnesota aspen forest and levels in excess of 80 animals per km² were observed by Bump et al. (1947) for woodlot habitat in New York and by Fischer and Keith (1974) for Alberta aspen forest. Typical densities found in aspen habitats of the Qu'Appelle Valley (32 to 50 per km²) are similar to those found in some of the best habitats elsewhere and the highest densities for the Qu'Appelle Valley (47 to 86 per km²) are comparable to optima attained in other regions. Size of study areas, field techniques, sampling intensity, statistical methodology, and observational bias undoubtedly vary between studies and possibly influence estimates included in Table 2. Despite these probable inconsistencies between studies, the comparison shows that the Qu'Appelle Valley supports high ruffed grouse densities.

3. Habitat Use

a) Vegetation at Observation Sites

For comparative purposes, data were divided into fall observations (before December 1) and winter observations (after December 1). All winter observations were made during the period when snow covered the ground. All autumn observations preceeded the period of permanent snow cover.

Tree cover was present at 73% of 408 fall observation sites and 74% of 235 winter sites. Aspen was present as a cover plant at 38% of the fall and 34% of the winter locations for an overall average of 36%. Maple, oak, ash and balsam poplar were frequent cover species but no other trees were important (Table 3). The proportion of total cover provided by various kinds of trees closely resembles the data on frequency (Table 4). Aspen was clearly the most important tree cover species, providing 50% of the fall and 38% of the winter cover. Maple, oak, balsam poplar and ash followed in importance,

TABLE 3. FREQUENCY OF TREES AT 408 FALL AND 235 WINTER GROUSE OBSERVATION SITES

SPECIES	FREQUENCY AS A COVER PLANT (%)				
	Fall 1977	Fall 1978	Both Years	Winter 1978	Fall-Winter Average
Aspen	39	38	38	34	36
Maple	13	19	16	15	16
Oak	6	3	5	24	15
Ash	8	8	8	18	13
Balsam Poplar	4	27	16	7	11
White Birch	3	10	6	3	5
Miscellaneous*	1	4	3	-	1

* White elm, spruce (*Picea*), and pincherry (*Prunus pensylvanica*).

TABLE 4. RELATIVE COVER RATING OF TREES AT 408 FALL AND 235 WINTER GROUSE

SPECIES	PERCENT OF TOTAL COVER POINTS*				
	Fall 1977	Fall 1978	Both Years	Winter 1978	Fall-Winter Average
Aspen	63	38	50	38	44
Maple	14	17	15	15	15
Oak	8	2	5	24	15
Balsam Poplar	5	27	16	7	11
Ash	6	7	7	15	11
White Birch	3	8	6	1	4
Miscellaneous**	1	2	1	0	1
TOTAL	100	101	100	100	101

* Total cover points for fall (1977) = 323, fall (1978) = 497, and winter (1978) = 469.
** White elm, spruce, pincherry.

each averaging 15% or less of the total fall and winter cover.

Tall shrubs were present at 97% of the fall and 96% of the winter observation sites. Chokecherry (39% in fall, 60% in winter, 50% overall) was the most frequent shrub. Saskatoon, willow, dogwood, hazelnut, hawthorn and aspen saplings were other tall shrubs with overall frequencies exceeding 10% while a variety of other species occurred at less than 10% of the sites (Table 5). Chokecherry (28%), saskatoon (17%), willow (16%), hazelnut (12%), and dogwood (10%) made up most of the tall shrub cover during fall and winter (Table 6).

Low shrubs and herbs were present as cover plants at 41% of the fall and 40% of the winter locations. Snowberry was by far the most frequent low plant (29%) and also provided the greatest proportion of the total low cover (57%). Rose rated second in both frequency (14%) and cover (23%) while other species were unimportant (Tables 7 and 8).

The above data indicate fall to winter increases in the use of oak, maple and ash trees as cover, and apparent seasonal declines in relative use of aspen and associated shrubs (willow, hazelnut and dogwood). This probably reflects biases in sampling procedures rather than actual changes in habitat preferences of grouse. Areas of extensive aspen habitat were less accessible in winter and, as a result, were surveyed less often than in the fall. In general, it seemed that habitat use by grouse was similar during late fall and winter. Some deviation from this pattern may have occurred in the early fall when young grouse were dispersing and were more apt to be found in marginal habitats.

The high fall and winter use of aspen cover by ruffed grouse in the Qu'Appelle Valley is not surprising as grouse are commonly associated with this tree species across much of North America (Aldrich 1963, Gullion 1972). In other regions, where both aspen and alternate sources of woody cover are

TABLE 5. FREQUENCY OF TALL SHRUBS AT 408 FALL AND 235 WINTER GROUSE OBSERVATION SITES

SPECIES	FREQUENCY AS A COVER PLANT (%)				
	Fall 1977	Fall 1978	Both Years	Winter 1978	Fall-Winter Average
Chokecherry	43	36	39	60	50
Saskatoon	23	42	32	42	37
Willow	31	33	32	28	30
Dogwood	30	38	34	22	28
Hazelnut	18	32	25	23	24
Hawthorn	2	8	5	21	13
Aspen	17	6	11	10	11
Bush-cranberry	6	6	6	2	4
Alder	5	5	5	0	3
Thorny buffaloberry	1	-	1	3	2
Balsam poplar	1	6	3	-	2
Oak	1	1	1	2	1
Pincherry	1	2	1	-	1
Miscellaneous*	4	7	5	+	3

* White birch, river birch (*Betula occidentalis*), ash, wolfwillow, raspberry, and unidentified.
\+ Indicates frequency less than 0.5%.

TABLE 6. RELATIVE COVER RATING OF TALL SHRUBS AT 408 FALL AND 235 WINTER GROUSE OBSERVATION SITES

SPECIES	PERCENT OF TOTAL COVER POINTS*				
	Fall 1977	Fall 1978	Both Years	Winter 1978	Fall-Winter Average
Chokecherry	29	18	24	32	28
Saskatoon	12	19	15	19	17
Willow	18	17	18	14	16
Hazelnut	14	13	13	6	10
Dogwood	9	16	13	11	12
Hawthorn	1	5	3	11	7
Aspen	9	2	6	4	5
Bush-cranberry	3	1	2	1	2
Alder	3	2	3	-	1
Thorny buffaloberry	1	-	1	2	1
Balsam poplar	+	2	1	-	1
Oak	+	+	+	1	-
Miscellaneous**	1	3	2	+	1

* Total cover points for fall (1977) = 757, fall (1978) = 944, and winter (1978) = 974.
** Includes white birch, river birch, pincherry, wolfwillow, ash, raspberry and unidentified species.

TABLE 7. FREQUENCY OF LOW SHRUBS AND HERBS AT 408 FALL AND 235 WINTER GROUSE OBSERVATION SITES

SPECIES	FREQUENCY AS A COVER PLANT (%)				
	Fall 1977	Fall 1978	Both Years	Winter 1978	Fall-Winter Average
Snowberry	27	22	25	33	29
Rose	22	16	19	10	14
Grasses and Sedges	14	14	14	4	9
Miscellaneous	2	6	4	2	3

TABLE 8. RELATIVE COVER RATING OF LOW SHRUBS AND HERBS AT 408 FALL AND 235 WINTER GROUSE OBSERVATION SITES

SPECIES	PERCENT OF TOTAL COVER POINTS*				
	Fall 1977	Fall 1978	Both Years	Winter 1978	Fall-Winter Average
Snowberry	45	39	42	71	57
Rose	34	23	29	16	23
Grasses and Sedges	19	26	23	9	16
Miscellaneous	1	11	6	4	5
TOTAL	99	99	100	100	101

* Total cover points for fall (1977) = 210, fall (1978) = 222, winter (1978) = 194.

available, ruffed grouse usually show a clear preference for aspen woodlands. Berner and Gysel (1969), working in Michigan, showed that grouse preferred aspen woods over upland or lowland forest types. They believed that the dense shrub and herb layers of the aspen habitat produced more food than did the other forest communities. In both Alberta and Minnesota, aspen woods were selected over other habitats during all seasons (Rusch and Keith 1971a, Gullion 1967, Gullion and Marshall 1968). In Wisconsin, however, Dorney (1959) found that grouse were about equally distributed throughout various forest types.

In places where aspen is not common, ruffed grouse use a variety of other cover types. Coniferous or mixed woodlands are important winter habitats in the northeastern United States (Bump et al. 1947, Edminster 1947). Near the southern range of ruffed grouse distribution, a variety of hardwood trees and understory plants provide cover (Lewis et al. 1968, Porath and Vohs 1972), while in Idaho, shrubby openings in coniferous woodlands are preferred (Marshall 1946). In general, regions that lack aspen support lower densities of grouse than do the aspen areas (Johnsgard 1973).

b) The Slope at Observation Sites

Sixty-five percent of 364 fall observations were made at sites with little (0-5°) slope, 30% were on moderate (6-10°) slopes, and only 6% were on steep slopes (>10°). The low incidence of grouse sightings in areas of steep slope (which make up much of the valley hillside) suggests that grouse avoid steeper inclines and prefer gentler ones. There are 2 possible explanations for this occurrence: i) ruffed grouse travel largely by walking and avoid steeper slopes which reduce their mobility; ii) the vegetation at level sites was richer and more productive than on steeper, usually drier, slopes and was accordingly, preferred habitat.

The relative importance of these factors could not be determined in the present study. The influence of slope on habitat use by grouse has received little attention in the literature. Edminster (1947) believed that grouse avoided steeper slopes whenever possible, but Bump et al. (1947) found no evidence that this occurred.

4. Roadside Counts of Grouse

a) The Influence of Habitat

Another way of studying habitat quality is by comparing habitats supporting many grouse to those supporting few grouse. For this purpose, I chose 8 areas for evening roadside counts of grouse. The choice of winter routes was determined mainly by the number of roads that were clear of snow and bordering on woodland habitat. These routes were located from 5 km west of #47 Highway to within 10 km of the Manitoba border. All major types of habitats were present along the routes although the count routes were generally more representative of non-aspen habitats. Two routes featured the aspen habitat typical of much of the valley.

Vegetation data, collected at 50 x 50-m plots situated at 150-m intervals along the roadsides, are described in Appendices II, III, IV and V. These data are summarized in three ways: by frequency, cover and dominance. *Frequency* refers to the proportion of plots in which a plant species rated at least a "1" by the cover scoring system. For example, if a plant rated 1 or more at 35 of 100 plots on a route, its frequency would be 35%. *Cover* refers to the total point score of a plant per 10 km of road side. If a route was 6.3 km long and the point score for a plant species was 53, the score per 10 km would equal (53/6.3) x 10 = 84.1 points. *Dominance* was defined as the proportion of the total cover along a route provided by a given plant species. If a species made up 43 of the 737 total cover points for a route, its dominance value would be calculated (43/737) x 100 = 5.8%.

Thus, dominance measures the relative importance of a species in the total plant community, cover indicates the total abundance of the plant along the route, and frequency expresses how widely the plant is distributed.

Results of roadside counts are summarized in Table 9. Each route was inspected at least 6 times, but because of weather and other logistical problems, some were inspected more often than others. Grouse were abundant along the Grenfell, Fort Esperance, Esterhazy West, and Cutarm Creek East routes where averages of 3.9 ± SD 3.3, 3.2 ± 3.2, 2.5 ± 1.7, and 2.5 ± 2.4 grouse per 10 km, respectively, were counted. Other routes, such as Crooked Lake and Tantallon East, supported fewer grouse.

To investigate the way in which the abundance of different plants might influence grouse densities, linear regression techniques were employed (Snedecor and Cochran 1967). Measurements of the vegetation were used as the independent (X) variables while "the numbers of grouse per 10 km of roadside" were the dependent (Y) variables. The regression analysis was restricted to plant species that occurred on at least 7 of the 8 count routes. Because there were major differences in the food and cover plants available on aspen-dominated routes (numbers 7 and 8) and the non-aspen routes (numbers 1 to 6), I also considered the latter separately. This provided information on the important plant species in non-aspen areas.

Grouse were most abundant on routes which supported healthy stands of aspens or chokecherries. Over the 8 areas, the pooled dominance rating of aspen plus chokecherry was the best predictor of grouse abundance (Table 10). The pooled frequency and pooled cover of aspen plus chokecherry were also good predictors of ruffed grouse density, for either non-aspen areas or all 8 routes considered together. The number of grouse per 10 km of roadside also correlated well with the frequency, cover, and dominance of chokecherry, especially in areas where aspen was uncommon. No such

TABLE 9. RESULTS OF GROUSE COUNTS ALONG 8 ROADSIDE ROUTES IN THE QU'APPELLE VALLEY, JANUARY TO MARCH 1978

ROUTE		LENGTH (km)	NO. COUNTS	MEAN NO. GROUSE OBSERVED (± SD)*	GROUSE PER 10 km
1.	Grenfell	8.0	6	3.2 ± 2.6	3.9 ± 3.3
2.	Crooked Lake	29.8	6	1.2 ± 0.4	0.4 ± 0.1
3.	Round Lake	21.9	9	2.9 ± 3.7	1.3 ± 1.7
4.	Esterhazy West	16.9	13	4.2 ± 2.8	2.5 ± 1.7
5.	Tantallon West	11.3	8	1.4 ± 1.3	1.2 ± 0.1
6.	Tantallon East	16.4	7	0.9 ± 0.9	0.5 ± 0.5
7.	Cutarm Creek	9.3	12	2.3 ± 2.3	2.5 ± 2.4
8.	Fort Esperance	8.5	8	2.8 ± 2.8	3.2 ± 3.2
	All Areas	-	-	2.4 ± 1.1	1.9 ± 1.3

* Includes sightings of grouse and fresh tracks.

TABLE 10. CORRELATION BETWEEN ROADSIDE GROUSE COUNTS (GROUSE PER 10 km) AND VEGETATION CHARACTERISTICS OF COUNT ROUTES

HABITAT CHARACTERISTICS	CORRELATION COEFFICIENT (r) ALL AREAS	NON-ASPEN AREAS
Frequency of woody vegetation	+0.46	+0.13
Shrub frequency	+0.52	+0.28
Shrub cover	+0.59	+0.72
Tree frequency	+0.48	+0.29
Tree cover	+0.46	+0.14
Total cover	+0.55	+0.83**
Chokecherry frequency	+0.72**	+0.92***
Chokecherry cover	+0.70*	+0.92***
Chokecherry dominance	+0.45	+0.91***
Saskatoon frequency	+0.17	+0.17
Saskatoon cover	+0.16	+0.24
Saskatoon dominance	-0.23	+0.04
Hawthorn frequency	-0.16	+0.04
Hawthorn cover	-0.53	-0.48
Hawthorn dominance	-0.66	-0.56
Willow frequency	+0.35	+0.31
Willow cover	+0.36	+0.37
Willow dominance	-0.19	-0.43
Aspen frequency	+0.51	+0.56
Aspen cover	+0.49	+0.12
Aspen dominance	+0.50	+0.27
Aspen & chokecherry frequency	+0.70*	+0.92***
Aspen & chokecherry cover	+0.71*	+0.92***
Aspen & chokecherry dominance	+0.91***	+0.92***
Maple frequency	+0.01	+0.52
Maple cover	-0.08	+0.43
Maple dominance	-0.41	-0.03

* p = 0.05
** p < 0.05
*** p < 0.01

relationship held for aspen alone, probably because this species was not abundant enough in most count areas to be properly tested by regression techniques. The total amount of woody cover was the only other variable (besides the various measurements of aspen and chokecherry occurrence) which correlated significantly with grouse abundance. Other woody plants showed little correlation with ruffed grouse densities and did not appear to influence the numbers of grouse found along the routes.

This type of analysis helped sort out the importance of a variety of habitat factors which might influence grouse numbers but it also has its limitations. The technique used to measure vegetation was semi-quantitative and might be prone to error or observer-induced biases. Some plants which were important food and cover species were not widespread along the count routes and were not included in the regression analysis (e.g. hazelnut, dogwood) while other species did not range greatly in abundance between areas and therefore, were not best studied with regression techniques. Because of identification difficulties, all species of willows were pooled, yet it is probable that some of these species *(Salix bebbiana, S. petiolaris)* have greater value to grouse than do others *(S. interior)*. Another weakness of the technique is that it fails to account for factors such as soil quality, differences in the productivity of plant communities, the stage of plant succession, or the influence of land use practices such as overgrazing. A careful study of these factors might greatly improve the regression model. Finally, correlation does not imply causation and high correlations between grouse densities and habitat parameters might be purely spurious. Despite this possibility, I believe that the relationship between grouse abundance and habitat quality is real. Experiments, in which the habitat is manipulated and the effects of such treatments on grouse numbers are evaluated, would be the best test of this, however.

b) Seasonal Reduction in Numbers

Roadside counts indicated that abundance of grouse on certain routes diminished as winter advanced while numbers on other routes remained stable. Relative decreases were most apparent in "poor" habitats which lacked significant chokecherry and aspen cover and as a result supported lower densities of grouse at the start of the count period in early January. Along routes where aspen and/or chokecherry were common, high densities of grouse existed at the start of the count period and January to March reductions in abundance were not obvious. Therefore, it seemed that the rate of winter population decrease was dependent on habitat quality. To further investigate this possibility, I classified routes as having "good" habitat if they supported an abundance of aspen and chokecherry (>50 aspen plus chokecherry points per 10 km of roadside) and "poor" habitat when the abundance of these plants was less. Three routes (numbers 1, 7 and 8) fit into the former category while 5 routes (numbers 2 to 6) were classified in the latter group. After the dates of the counts were transformed (January 1 = Day 1, February 1 = Day 32, etc.) the abundance of grouse in "good" and "poor" habitats was tested for correlation with time of year. This analysis revealed that the number of grouse on "poor" routes decreased significantly with time ($r=-0.38$, 41 df, $P<0.02$) while the numbers in other areas remained stable ($r=+0.19$, 24 df, $P>0.10$). The former relationship is shown in Figure 3.

The reduction in numbers of grouse sighted between early January and mid-March could reflect actual mortality, or movement of grouse away from marginal habitats. As movements of grouse seem to be minimal during winter (Hale and Dorney 1963), mortality is the most probable factor involved in the decline.

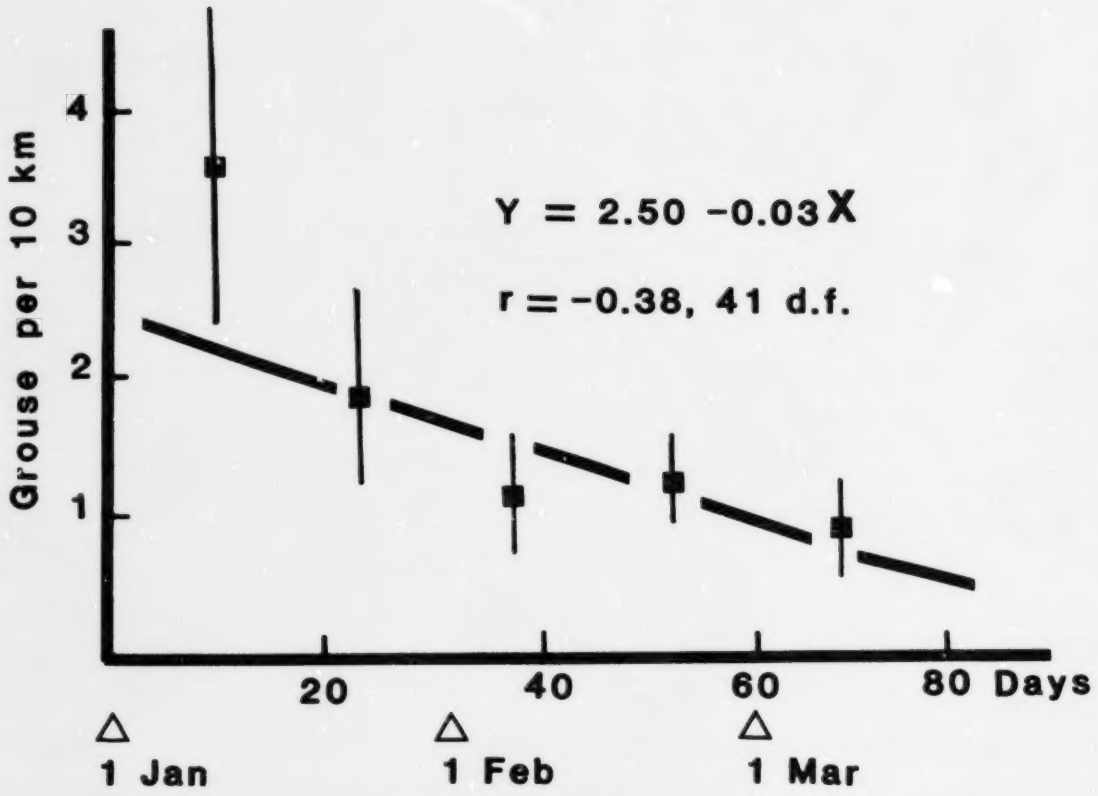

FIGURE 3. January to March reduction in the number of grouse observed along census routes with "marginal" habitat. Points indicate means and vertical lines are standard errors for each 15 day interval.

5. Counts of Drumming Males

Drumming male grouse were most abundant in aspen and balsam poplar habitats. Drumming frequencies in these communities approached 9%, a figure well above the 1-2% frequency for the oak, maple and ash communities (Figure 4). A small sample (n=27) for tall shrub communities with no tree cover revealed no drumming males. Because of small sample sizes, statistical comparisons between all communities were not possible. A comparison of *Populus* communities to pooled data for the oak, ash, maple and shrub habitats reveals a highly significant difference between distributions (X^2=18.41, 1df, P<0.005). Thus, aspen or balsam poplar woodlands were most frequently used by drumming grouse.

Succession and grazing pressure also influenced the use of woodlands as drumming areas. A test for linear trend in proportions (Snedecor and Cochran 1967:246) revealed that drumming frequencies increased with the height of the canopy layer in all of the woodland communities considered together (P<0.01) or in the *Populus* communities considered separately (P<0.01). Because of small sample sizes, non-poplar habitats could not be analysed separately. Woodlands were first used for drumming when the trees reached 6 m in height but maximum densities of drummers did not occur until the tree layer was 10 m or more in height (Figure 5).

The frequency of drumming also varied according to the intensity of grazing pressure (X^2=8.98, 3 df, P<0.05). Drumming frequencies were lowest in moderately or heavily grazed communities and highest where grazing pressure was light (Figure 6). This relationship was not significant for the aspen communities considered separately (P>0.10) possibly because of small sample sizes for habitats that were moderately or heavily grazed. The apparent increase in drumming frequency from 7% in ungrazed areas to 11% in lightly grazed communities could also be an artifact of the small sample sizes but

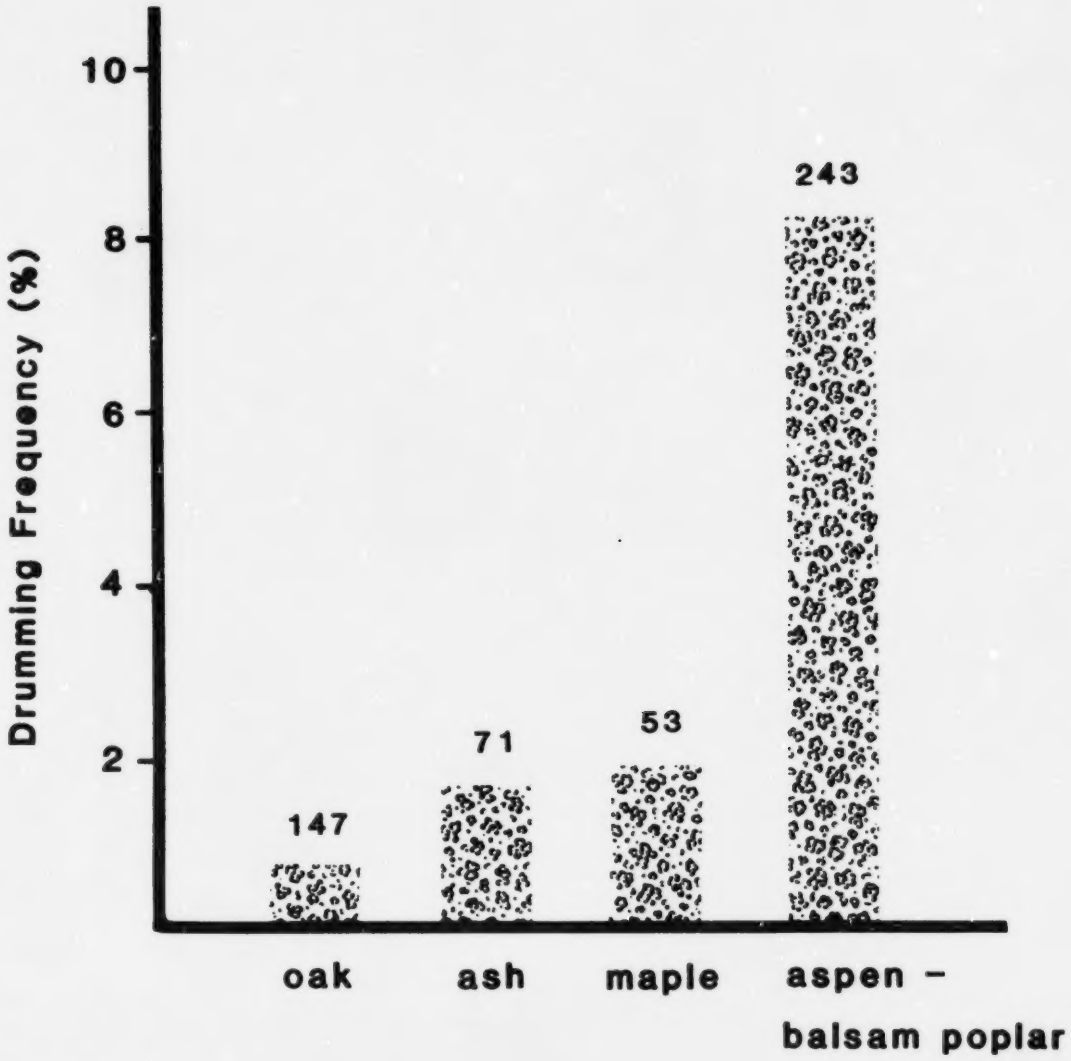

FIGURE 4. The frequency of drumming grouse (percentage of 2 minute stops where at least one grouse was heard drumming) in 4 habitat types. Sample sizes are indicated for each habitat.

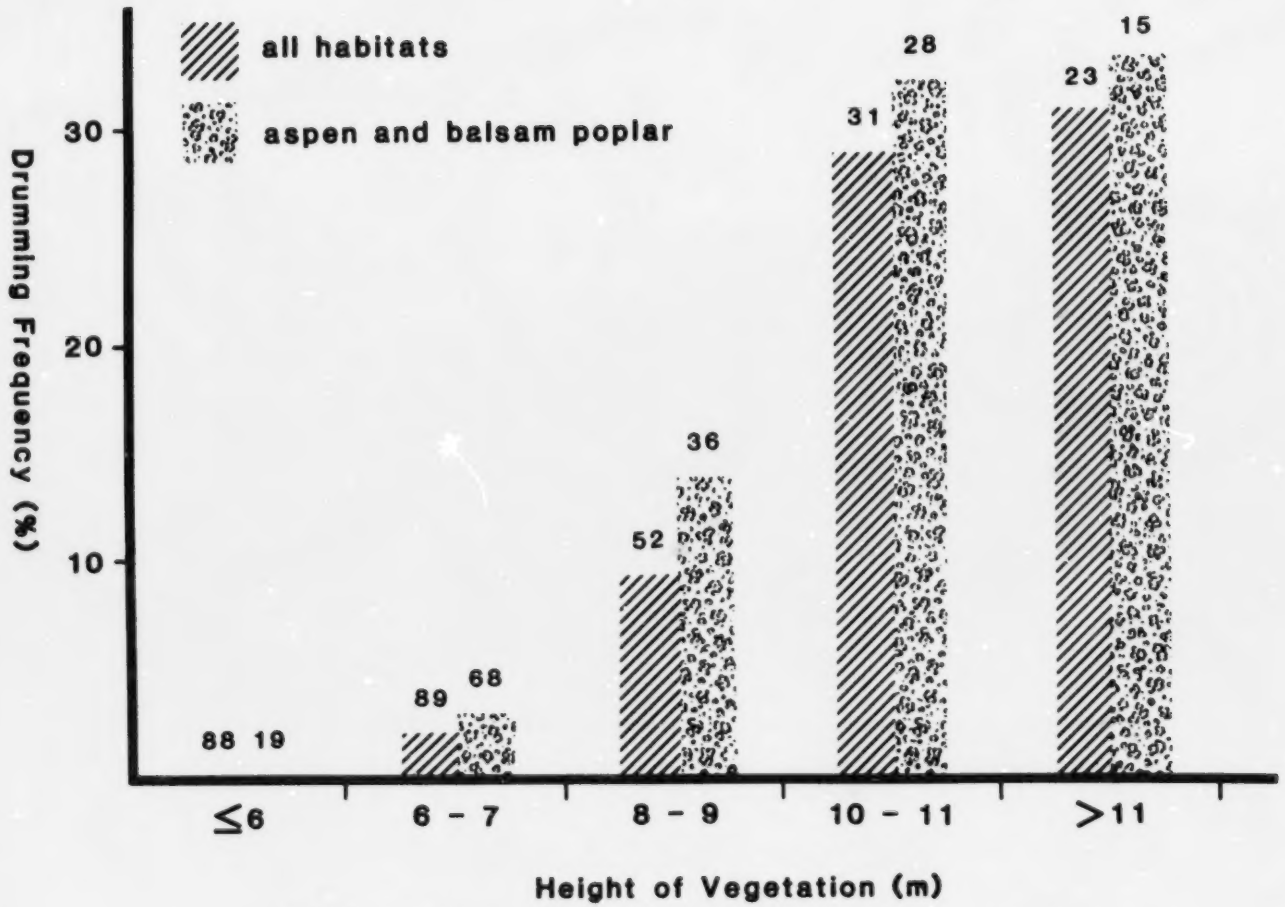

FIGURE 5. Influence of vegetation height on use of woodlands by drumming grouse.

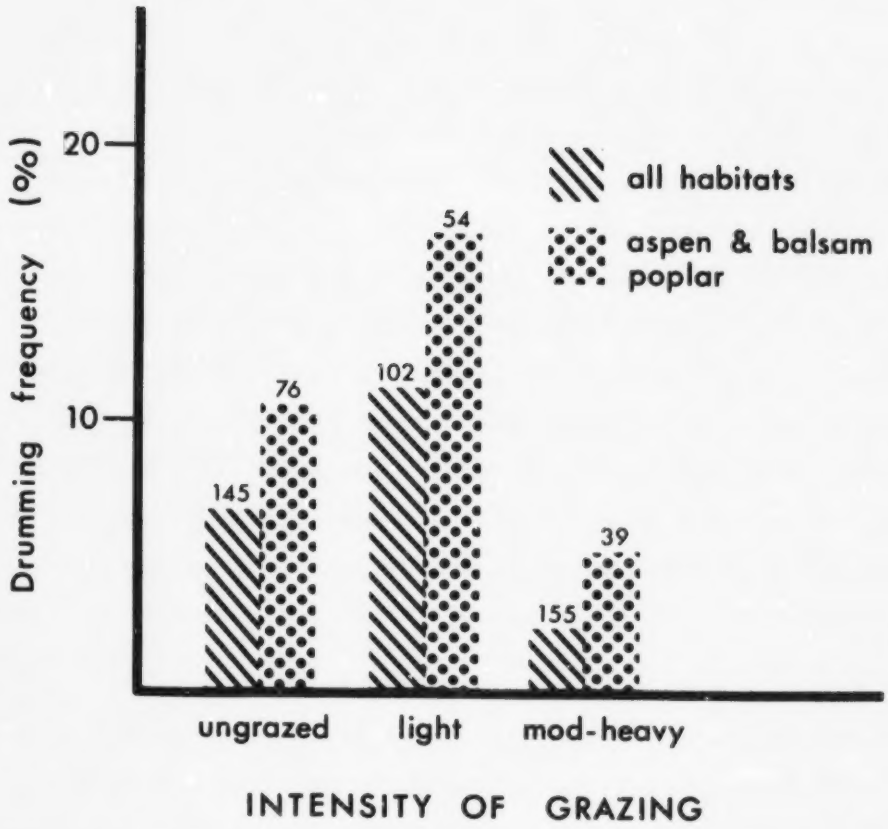

FIGURE 6. Effect of grazing pressure on use of woodlands by drumming grouse.

the data are not inconsistent with the hypothesis that light grazing increases ruffed grouse densities in some types of woodlands (Dorney 1959, Weatherill and Keith 1969). In contrast, excessive grazing and browsing by cattle or white-tailed deer *(Odocoileus virginianus)* seems to lower the carrying capacity of the habitat for ruffed grouse (Dorney 1959, Palmer 1963, Weatherill and Keith 1969).

Why does overgrazing reduce grouse density while light grazing seems to have little effect? The answer probably lies in the responses of the herb and shrub layers to different grazing intensities. Light grazing reduces the herb layer but has little effect on shrubs. Heavy grazing reduces both layers. Several studies show that male grouse prefer well-developed tall shrub or sapling growth, and a relatively open ground layer near their display sites (Palmer 1963, Boag and Sumanik 1969, Rusch and Keith 1971a). Such habitats provide the male with a good view of the surrounding landscape, a suitable area for display, and protection from avian predators. Studies by Gullion and Marshall (1968) and Rusch and Keith (1971a) revealed that grouse lived longest in habitats with well-developed tall shrub layers. In contrast, ground or "horizontal" cover is thought to be detrimental to survival of grouse because it "provides better hunting cover for ..... predators than escape cover for grouse" (Gullion 1970:101).

My observations suggest that factors in addition to the abundance of tall shrub cover greatly influenced selection of drumming sites by males. Some parts of the bur oak, maple and ash woods supported vigorous growths of shrubs comparable to that in aspen and balsam poplar woodlands. On this basis, these non-poplar habitats should have been readily used as drumming sites. Perhaps a shortage of food or suitable drumming logs limited the use of such habitats. Also, as male ruffed grouse are sedentary in nature, remaining on a small home range throughout much of the year, the habitat they select must be useful on a year-round basis. The great use of aspen

woods by drumming males may only reflect the year round superiority of these woodlands as grouse cover.

6. Food Habits

The crop contents of 70 ruffed grouse, collected in or near the Qu'Appelle Valley between 1970 and 1978, are summarized in Table 11. In the fall of 1978, a sample of 69 crops was obtained from the Moose Mountain region located about 80 km south of the valley. The vegetation of the latter area is similar to that of aspen woodlands in the Qu'Appelle Valley.

Chokecherry fruits were clearly the most common food item in the valley, making up 46% of the total dry weight. The fruits of hawthorn (16%), rose (5%) and dogwood (4%), and a variety of green materials (5%) were also highly used. For the Moose Mountain sample, rose fruits (27%), hazelnut catkins (19%), clover greens (16%), miscellaneous green material (12%) and snowberry fruits (8%) made up much of the dry weight. Clover was a more important food item in the Qu'Appelle Valley than indicated in Table 11. All of the green material from the earlier sample of crops was pooled, therefore some of the dry weight attributed to "miscellaneous green material" was actually clover. Other important green foods for both areas were, in descending order of use, the leaves of aspen, dandelion *(Taraxicum sp.)* and strawberry *(Fragaria sp.)*.

Differences in food habits between the two study areas reflect the opportunistic nature of ruffed grouse feeding behavior in fall. During fall, grouse take foods which are readily available and abundant fruits such as chokecherry in the Qu'Appelle Valley, and rose in the Moose Mountains, make up much of the diet. Overall, fruits comprised 65% of the dry weight of autumn foods for both areas while buds, twigs and catkins made up 16%, green materials 15%, and miscellaneous materials 3%. The tall shrub layer produced 61% of the fall foods. Low shrubs accounted for 20%, herbs (18%)

TABLE 11. FALL FOODS OF 70 RUFFED GROUSE COLLECTED IN THE QU'APPELLE VALLEY (1970 - 1978) AND 69 GROUSE COLLECTED IN THE MOOSE MOUNTAIN AREA (1978)

SPECIES	% TOTAL DRY WEIGHT			% FREQUENCY		
	QU'APPELLE VALLEY	MOOSE MOUNTAIN	BOTH AREAS	QU'APPELLE VALLEY	MOOSE MOUNTAIN	BOTH AREAS
Chokecherry fruits	46	12	32	37	16	27
Rose fruits	5	27	14	11	28	19
Hawthorn fruits	16	-	9	13	-	6
Hazelnut catkins	2	19	9	19	35	27
Misc. green mat.*	5	12	8	70	65	68
Clover leaves	2	16	7	13	52	32
Snowberry fruits	1	8	4	30	38	34
Dogwood fruits	4	-	2	19	-	9
Bush-cranberry fruits	1	2	2	7	13	10
Misc. buds**	2	2	2	41	28	35
Willow buds	2	+	1	7	1	4
Aspen buds	2	1	1	17	6	12
Saskatoon buds	2	-	1	16	-	8
Chokecherry buds	2	+	1	27	1	14
Barley	2	-	1	3	-	1
Bearberry fruits***	2	-	1	6	-	3
Wheat	1	+	1	7	1	4
Oats	1	-	+	1	-	1
Willow leaf galls	1	+	+	9	4	6
Balsam poplar buds	+	+	+	4	3	4
Misc. seeds	+	1	+	4	15	9
Saskatoon fruits	+	-	+	3	-	1
Pincherry fruits	-	+	+	-	1	1
Invertebrates	+	+	+	4	9	6
TOTAL	100	100	100	-	-	-

* Aspen leaves, dandelion, strawberry, grasses, sedges and unidentified.
** Hazelnut, dogwood, hawthorn, bush-cranberry, snowberry, and unidentified.
*** *Arctostaphylos uva-ursi*
\+ Less than 0.5%.

and trees (2%).

In winter, grouse fed frequently on chokecherry (46% of 85 observations). The bulk of the food must have been buds as there were few fruits on the shrubs at this time. Aspen was the second most frequently observed food item (14% of winter observations) and a variety of other shrubs and trees made up the remaining 40% of the observations (Table 12). Species eaten at more than 5% of the sites were willow, green ash, saskatoon, and thorny buffaloberry. It was difficult to observe grouse feeding in dense, low-growing plants and the importance of shrubs such as hazelnut, snowberry and rose are likely underestimated in Table 12. The sample size is rather small and it is impossible to make any definite conclusion except that chokecherry and aspen are important winter foods. Buds of willow and saskatoon, and catkins of hazelnut appeared frequently as food items in late fall and it is probable that they are also important winter foods.

There are numerous studies of ruffed grouse food habits reported in the literature. Much of the earlier information was summarized by Korschgen (1966) who reviewed 24 food habits studies. These, and other pertinent investigations (Hungerford 1957, Phillips 1967, Svoboda and Gullion 1972, Doerr et al. 1974) are briefly summarized in Table 13. Only locally distributed genera of shrubs and trees are considered in this tabulation. Aspens and other poplars have been reported as important foods in 62% of the studies, birches in 38%, oaks in 31%, cherries and hawthorns in 28%, willows and dogwoods in 21%, and hazelnuts in 14%. Juneberries (including saskatoons), roses, maples, snowberries, and buffaloberries were important foods in less than 10% of the areas studied. Thus, grouse are widely associated with several genera of food plants. Three of these genera (*Betula, Quercus,* and *Acer*) are common in the Qu'Appelle but not readily used for food. The other 10 genera are thought to be of value to ruffed grouse in the valley.

TABLE 12. PLANT SPECIES ON WHICH GROUSE WERE OBSERVED FEEDING DURING FALL AND WINTER

SPECIES	NUMBER OF OBSERVATIONS (%)					
	Fall		Winter		Both Seasons	
Chokecherry	7	(32)	39	(46)	46	(43)
Aspen	1	(5)	12	(14)	13	(12)
Willow	6	(27)	5	(6)	11	(10)
Saskatoon	4	(18)	6	(7)	10	(9)
Green Ash	0	(0)	8	(9)	8	(7)
Thorny buffaloberry	2	(9)	5	(6)	7	(7)
Snowberry	0	(0)	3	(4)	3	(3)
Hawthorn	1	(5)	2	(2)	3	(3)
Dogwood	0	(0)	2	(2)	2	(2)
Maple	0	(0)	1	(1)	1	(1)
Hazelnut	0	(0)	1	(1)	1	(1)
Rose	1	(5)	0	(0)	1	(1)
Unidentified grain	0	(0)	1	(1)	1	(1)
TOTAL	22	(101)	85	(99)	107	(100)

TABLE 13. FREQUENCY OF 13 SELECTED GENERA OF SHRUBS AND TREES AS IMPORTANT RUFFED GROUSE FOODS ACROSS NORTH AMERICA*

GENUS	NO. TIMES REPORTED AS AN IMPORTANT FOOD	FREQUENCY (%) **
Poplar (*Populus*) ***	18	62
Birch (*Betula*)	11	38
Oak (*Quercus*)	9	31
Cherry (*Prunus*) ***	8	28
Hawthorn (*Crataegus*)***	8	28
Willow (*Salix*)***	6	21
Dogwood (*Cornus*)***	6	21
Hazelnut (*Corylus*)***	4	14
Juneberry (*Amelanchier*)***	3	10
Rose (*Rosa*)***	3	10
Maple (*Acer*)	3	10
Snowberry (*Symphoricarpos*)***	2	7
Buffaloberry (*Shepherdia*)***	1	3

* data from Korschgen (1966), Hungerford (1957), Phillips (1967), Svoboda and Gullion (1972), Doerr *et al.* (1974).
** % of 29 studies in which genus was an important food item.
*** believed to be important food in the Qu'Appelle Valley.

Studies of the feeding ecology of ruffed grouse by Svoboda and Gullion (1972) in Minnesota and Doerr et al. (1974) in Alberta, are particularly relevant to Saskatchewan as the forest habitats are similar. In Minnesota, the primary food resource of grouse is the male or staminate flower bud of aspen *(Populus tremuloides, P. grandidentata)*. These species can meet most of the energy requirements of grouse throughout the fall to spring period and their presence is believed to be the most important factor determining abundance of grouse in the forest. Trees older than 25 years provide most of the food and those producing buds rich in protein are most valuable. Other significant foods in this region are beaked hazelnut catkins, but they are secondary in importance to aspens. In Alberta, staminate buds of trembling aspen are the most important foods of grouse in winter but flower buds of willow follow closely in value. Plants with higher than average protein and potassium contents are preferred. Other species commonly eaten include rose, saskatoon, and buffaloberry *(Shepherdia canadensis)* fruits; hazelnut catkins; and balsam poplar buds. Both Minnesota and Alberta studies indicate that in some years, the staminate flower buds of aspens are not preferred foods even though they are abundant. The presence of other foods is undoubtedly important to grouse at such times. In the Qu'Appelle Valley, chokecherry, hazelnut, willow and saskatoon may take on greater importance in the winter diet under such conditions.

A report by Phillips (1967) shows that Utah ruffed grouse eat many of the same food plants used by grouse in the Qu'Appelle Valley. Preferred fall foods in Utah were rose fruits and aspen leaves. The buds and twigs of chokecherry, aspen, maple, willow and saskatoon are significant winter foods.

7. Aggregations of Grouse

Most grouse broods had already broken up when the study began in late September. In early fall 1977 (before October 31), 28% of the grouse

were found in groups. This proportion gradually increased as winter approached and peaked in December and January when 71% of the grouse were grouped (Table 14). After that, the tendency towards group formation decreased and by March only 36% of the grouse remained in aggregations. Groups ranged in size from 2 to 8 birds, but 2 was the most common size (Table 15).

Godfrey and Marshall (1969) reported that the groups of grouse found after brood break-up and dispersal were made up of non-siblings. Bump et al. (1947) believed that such aggregations were not true flocks. In Alberta, Doerr et al. (1974) monitored the activities of feeding groups of ruffed grouse and showed that average group size increased from fall to mid-winter and then gradually declined. This reduction was not caused by losses to predators but instead reflected the increasing social intolerances exhibited by male grouse as spring advanced. Other studies suggest that most winter mortality of ruffed grouse occurs before December 1 (Rusch and Keith 1971b, Gullion 1972) and thus support the view that the reduction of aggregations in late winter is caused by social behavior.

In the Qu'Appelle Valley there were absolute decreases in numbers of grouse seen on some count routes in winter (discussed in section IV. 4.) as well as decreases in the percentage of grouse found in groups. The disappearance of grouse from certain count areas suggests that mortality and/or dispersal were also important in reducing the size of aggregations.

TABLE 14. FALL AND WINTER CHANGES IN THE FREQUENCY OF GROUSE AGGREGATIONS, QU'APPELLE VALLEY, OCTOBER, 1977 TO MARCH, 1978

INTERVAL	NO. GROUSE	% GROUSE IN GROUPS
October 1 - 31	81	28
November 1 - 30	109	37
December 1 - January 31	68	71
February 1 - 28	46	50
March 1 - 31	31	36

TABLE 15. A FREQUENCY DISTRIBUTION OF GROUSE AGGREGATION SIZES, FALL AND WINTER, 1977 AND 1978

GROUP SIZE	FREQUENCY	PERCENT
Alone	316	79
2	56	14
3	13	3
4	9	2
5	3	1
6	3	1
7	1	< 1
8	1	< 1
TOTAL	402	100

V. CONCLUDING DISCUSSION

Population indices and data on habitat use suggest that ruffed grouse densities in the Qu'Appelle Valley were greatly influenced by the type of habitat present. Aspen woods and communities with abundant chokecherry shrubs, supported highest grouse densities. In fall and winter, such communities were likely of value to grouse because they provided: i) abundant food and ii) protection from predators (Gullion 1970, 1977; Rusch and Keith 1971a). The possible relationships between habitat preferences, predation and food supply are discussed below.

Some authorities believe that predators limit the numbers of ruffed grouse, particularly when alternate sources of prey are in short supply (Rusch and Keith 1971b, Keith 1974, Rusch et al. 1978). Gullion (1970) suggested that although predation seldom limited populations, it was the ultimate fate of more than 80% of the ruffed grouse on his study area in Minnesota. Gullion and Marshall (1968) and Rusch and Keith (1971a) reported that predation rates were highest and life expectancies of grouse were lowest in habitats where shrub and tree cover was poor. These biologists noted that secondary habitats, such as those with tall conifer cover and sparse understories, afforded grouse little protection from predators. Thus, protection from predators is likely an important factor influencing habitat selection by grouse.

Gullion (1970, 1977) classified grouse cover as "vertical" or "horizontal". Vertical cover is upright cover provided by trees and tall shrubs. In its best form, it provides ruffed grouse with a good view of the surrounding terrain and also provides a barrier against attack by raptors. In areas of good vertical cover, grouse are apt to survive well because they can spot the approach of ground predators and are protected from above against surprise attacks of raptors. Horizontal cover includes brush piles, slashing, fallen trees, and low vegetation and is considered as a negative feature of the habitat because it

provides good hunting cover for predators. Ruffed grouse in the Qu'Appelle Valley typically selected habitats with good vertical and sparse horizontal cover. Grouse preferred habitats with prominent tall shrub and tree layers that featured species such as aspen, chokecherry, hazelnut and others. These plants grew with even stem spacing and supported little cover below. Tall shrubs were found at 97% of the grouse observation sites in fall and winter suggesting the special value of this stratum. Trees were also frequent (73%) but low cover was far less common (41%). Some species, which did not appear to be useful cover plants because of their low growth form (i.e. rose, snowberry), still showed up frequently at grouse observation sites. Perhaps this reflects the utility of these species as food or their overall abundance in the valley.

Many ecologists believe that food is the ultimate factor limiting the numbers of most vertebrates (Lack 1954, 1966; Wynne-Edwards 1962), a viewpoint that has also been expressed concerning grouse populations (Watson and Moss 1972, Svoboda and Gullion 1972). As noted by Doerr et al. (1974), most species of grouse are nutritional specialists (dependent on 1 or 2 species of food plants) for at least part of the year. Winter counts in the Qu'Appelle Valley revealed that ruffed grouse were most numerous in areas where important food plants (e.g. chokecherry, aspen and its associated shrubs -- hazelnut and willow) were abundant. These same few species of plants made up much of the grouse cover. It therefore appeared that the distribution and abundance of these shrubs and trees greatly influenced relative densities of grouse in different parts of the valley.

Grouse population densities in the ash, oak, and maple habitats together averaged 22 to 33 per km^2 in the fall. This average was about 70% of the population density recorded for aspen habitats (32 to 45 grouse per km^2). Spring densities of drumming males in non-aspen woodlands (as indicated by drumming frequencies) were only 10-20% of those recorded for aspen

communities. These data indicate that many grouse which had settled in non-aspen habitats in fall, either died or dispersed into other areas by spring. Winter roadside counts also support this contention as numbers of grouse in "good" habitats (where chokecherry, aspen and associated shrubs were abundant) remained stable while numbers of grouse in marginal habitats declined sharply.

The above findings are consistent with the hypothesis that good habitats, especially aspen woods, support most of the breeding grouse in spring. In such areas, large numbers of young are produced, many of which disperse in fall and settle in marginal woodland habitats. Although fall population densities in poorer habitats may be high, winter mortality is severe and only a small cohort (which contributes little to successive populations) survives until spring. This hypothesis is supported by limited field data and can only be tested through intensive studies which involve the observation of marked grouse and assessments of the annual production of young in each habitat type. Particularly, it must be shown that the disappearance of grouse from poor habitats in winter is caused by mortality and not dispersal.

Management Implications

In the Qu'Appelle Valley, the greatest densities of grouse were found in aspen woods, especially those with a well-developed tall shrub layer, moist spring seepage openings, and a high frequency of edge. Here, grouse attained population densities comparable to many of the high population levels reported in the literature. Maintenance of such habitats in their present form is therefore desirable. Other areas of aspen woods in the valley can possibly support similar population densities when properly managed. Habitat management practices of potential value to ruffed grouse are discussed below. The effects that such manipulations would have on grouse densities are largely hypothetical and need to be further evaluated.

Methods for improving aspen forest for ruffed grouse have been detailed by Gullion (1972, 1977). As the ruffed grouse has a small home range, Gullion's technique centers around providing all the needs for each grouse in a 2.5 to 4.0-ha area. In general, young dense stands of aspen suckers (less than 10 years old) are good habitat for broods. Stands of 10 to 25 years in age are best for breeding and winter cover, and older stands provide the best crop of staminate buds for winter food. Different blocks of an aspen woods can be cut on a 10-year rotation so that all these age classes are present in each 4-ha area. Interspersion of different cover types is important as extensive young or old stands of aspen by themselves may be of little value to grouse. It is also important that felled trees, slash, and other debris is removed when an area is cleared. Such cover is detrimental to grouse as it provides cover for ground predators and reduces the regeneration of aspen and other shrubs in the clearing.

This type of management of the aspen ecosystem is probably in line with the goal of preservation of the natural environment of the Qu'Appelle Valley. Aspen forests are essentially fire-dependent and short term in nature. Stands of greater than 50 years in age are "old" and under natural conditions, subject to frequent fires. Small-scale clearing and/or burning of natural aspen woods would be a useful tool for increasing the abundance of successional species of plants and animals, maintaining a high species diversity, and producing browse for deer, as well as maintaining dense grouse populations.

Aspen regenerates quickly from its root system and is a species easily managed for grouse, but shrubs such as chokecherry, hazelnut and willow also have great potential. Planting of chokecherry on cleared land that is being reclaimed for wildlife, would be a beneficial habitat improvement technique. Provision of alternate food plants in areas with an impoverished tall shrub flora would provide grouse with a good food supply during winters when other foods are scarce or of poor quality. Chokecherry, willow (excluding

Salix interior), saskatoon, hawthorn and beaked hazelnut are species with greatest potential.

In the Qu'Appelle Valley, overgrazing by livestock is a significant problem from both agricultural and environmental viewpoints. Overgrazing leaves forage plants in a weakened state, cuts back on the annual production of forage for livestock, and eliminates valuable food and cover for wildlife. In ruffed grouse habitats, excessive grazing prevents important tall shrubs from becoming abundant or large enough, to be useful as food and cover. Undesirable grasses, forbs and low shrubs invade woodlands under these conditions causing further habitat deterioration.

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APPENDIX I. THE OBSERVED AND EXPECTED NUMBERS OF GROUSE FLUSHED IN EACH HABITAT DURING THE FALL CENSUS

HABITAT TYPE	TRANSECT LENGTH km	TRANSECT LENGTH (%)	GROUSE FLUSHED* Obs.	GROUSE FLUSHED* Exp.	X^2
Ash	20.8	(6.65)	12	16.63	1.287
Maple	28.6	(9.14)	10	22.86	7.233
Oak	35.0	(11.19)	15	27.97	6.016
Aspen	228.4	(73.02)	213	182.55	5.081
TOTAL	312.8	(100.00)	250	250.01	19.617

* Expected values were calculated on the assumption that if grouse are distributed independently of habitat type, the number of birds found in a given habitat should be proportional to the total length of transects there.

APPENDIX II. VEGETATION CHARACTERISTICS OF THE 8 COUNT ROUTES

CHARACTERISTIC	ROUTE 1	2	3	4	5	6	7	8	$\bar{X} \pm$ SD
Tree frequency	27.4	24.4	31.5	24.7	28.2	21.1	81.0	88.5	40.9 ± 27.3
Tall shrub frequency	50.0	51.2	37.0	40.2	43.7	36.8	67.2	88.5	51.8 ± 17.9
Freqency of woody plants	51.6	51.2	41.7	45.4	59.2	42.1	89.7	94.2	59.4 ± 20.9
Tree cover*	41.9	39.1	47.3	58.7	71.9	42.1	199.9	225.0	90.7 ± 76.2
Tall shrub cover	133.9	106.7	84.3	98.1	70.5	68.6	169.0	334.6	133.2 ± 88.1
Total woody cover	175.8	145.8	131.6	156.8	142.4	110.7	368.9	559.6	224.0 ± 157.9

* Cover expressed as points per 16 km of road.

APPENDIX III. TREES AND TALL SHRUB COVER (POINTS PER 16 km) ALONG THE 8 COUNT ROUTES

SPECIES	ROUTE 1	2	3	4	5	6	7	8	$\bar{x}$	±	SD
Aspen	14.5	5.9	0.8	3.1	11.3	6.3	101.7	180.8	40.6	±	65.8
Oak	-	-	-	27.8	43.7	22.1	63.8	-	19.7	±	24.3
Maple	16.1	10.7	21.3	21.6	16.9	13.7	8.6	7.7	14.6	±	5.4
Ash	8.1	22.5	25.2	6.2	-	-	1.7	-	8.0	±	10.3
Balsam poplar	-	-	-	-	-	-	24.1	32.7	7.1	±	13.3
White birch	-	-	-	-	-	-	-	3.8	0.5	±	1.3
Elm	3.2	-	-	-	-	-	-	-	0.4	±	1.1
Saskatoon	45.2	53.3	45.7	28.9	11.3	9.5	24.1	30.8	31.1	±	16.1
Chokecherry	72.6	23.1	26.0	36.1	15.5	5.3	32.8	15.4	28.4	±	20.5
Willow	4.8	3.6	3.9	10.3	15.5	26.3	46.6	84.6	24.5	±	28.4
Hazelnut	-	-	-	-	7.0	-	27.6	103.8	17.3	±	36.2
Hawthorn	8.1	17.2	2.4	12.4	9.9	21.1	15.5	-	10.8	±	7.2
Dogwood	-	0.6	-	2.1	-	2.1	10.3	75.0	11.3	±	26.0
Thorny buffaloberry	-	-	-	2.1	8.6	-	-	-	1.3	±	3.0
Others	3.2	8.9	6.3	6.2	2.8	4.2	12.1	25.0	8.6	±	7.3
TOTAL	175.8	145.8	131.6	156.8	142.4	110.6	368.9	559.6	223.9	±	157.9

APPENDIX IV. PERCENT FREQUENCIES OF TREES AND TALL SHRUBS ALONG THE 8 COUNT ROUTES

SPECIES	ROUTE								$\bar{X}$	±	SD	Const.*
	1	2	3	4	5	6	7	8				
Aspen	9.7	4.7	0.8	2.1	5.6	3.2	50.0	84.6	20.1	±	30.7	100
Oak	-	-	-	13.4	26.8	10.5	37.9	-	11.1	±	14.5	50
Maple	9.7	7.1	11.8	11.3	9.9	6.3	8.6	3.8	8.6	±	2.7	100
Ash	8.1	16.0	19.7	2.1	-	-	1.7	-	6.0	±	7.9	63
Balsam poplar	-	-	-	-	-	-	10.3	17.3	3.5	±	6.7	25
White birch	-	-	-	-	-	-	-	1.9	0.2	±	0.7	13
Elm	1.6	-	-	-	-	-	-	-	0.2	±	0.6	13
Saskatoon	22.6	27.8	26.0	15.5	8.5	6.3	17.2	19.2	17.9	±	7.7	100
Chokecherry	37.1	15.4	15.0	22.7	11.3	3.2	19.0	11.5	16.9	±	10.0	100
Willow	3.2	1.8	2.4	6.2	14.1	13.7	27.6	42.3	13.9	±	14.4	100
Hazelnut	-	-	-	-	2.8	-	13.8	48.1	8.1	±	16.9	38
Hawthorn	4.8	9.5	2.4	8.2	8.5	14.7	8.6	-	7.1	±	4.6	88
Dogwood	-	0.6	-	1.0	-	2.1	8.6	38.5	6.4	±	13.3	63
Thorny buffaloberry	-	-	-	1.0	5.6	-	-	-	0.8	±	2.0	25
Others	3.2	8.3	5.5	6.2	2.8	4.2	10.3	15.4	7.0	±	4.2	100

* Constancy is the percentage of routes on which the plant species was recorded.

APPENDIX V. RELATIVE DOMINANCE* OF TREES AND TALL SHRUBS ALONG THE 8 COUNT ROUTES

SPECIES	ROUTE 1	2	3	4	5	6	7	8	$\bar{X}$	±	SD
Aspen	8.3	4.1	0.6	2.0	7.9	5.7	27.6	32.3	11.1	±	12.0
Oak	-	-	-	17.8	30.7	20.0	17.3	-	10.7	±	12.2
Maple	9.2	7.3	16.2	13.8	11.9	12.4	2.3	1.4	9.3	±	5.3
Ash	4.6	15.4	19.2	3.9	-	-	0.5	-	5.5	±	7.6
Balsam poplar	-	-	-	-	-	-	6.5	5.8	1.5	±	2.9
White birch	-	-	-	-	-	-	-	0.7	0.1	±	0.2
Elm	1.8	-	-	-	-	-	-	-	0.2	±	0.6
Saskatoon	25.7	36.6	34.7	18.4	7.9	8.6	6.5	5.5	18.0	±	12.9
Chokecherry	41.3	15.9	19.8	23.0	10.9	4.8	8.9	2.7	15.9	±	12.4
Willow	2.6	2.4	3.0	6.6	10.9	23.8	12.6	15.1	9.6	±	7.5
Hazelnut	-	-	-	-	5.0	-	7.5	18.6	3.9	±	6.6
Hawthorn	4.6	11.8	1.8	7.9	6.9	19.0	4.2	-	7.0	±	6.1
Dogwood	-	0.4	-	1.3	-	1.9	2.8	13.4	2.5	±	4.5
Thorny buffaloberry	-	-	-	1.3	5.9	-	-	-	0.9	±	2.1
Others	1.8	6.1	4.8	3.9	2.0	3.9	3.3	4.5	3.8	±	1.4
TOTAL	99.9	100.0	100.1	99.9	100.0	100.1	100.0	100.0	100.0	_	

* Percentage of total cover along each route